IBM

IBM 604 Electronic Calculator

604

004

Manual of Operation

Model 004 Supplement

Contents

Introduction

This brief summary of the 604/004 calculating punch is intended as a supplement to the present 604 manual, which deals with the Model 001. Much of the 604 manual is of value to the user of the Model 004, as the programming principles of the two machines are broadly the same.

The supplement is written in six sections:

(1) Reading information into the calculator.
(2) Calculation.
(3) Punching results.
(4) Checking results.
(5) Gang punching.
(6) Lights, Switches and Control Buttons.

Part 1 : Reading Information into the Calculator

When using the 521 as the Read-Punch unit of the 604, the On hubs of the Calculate Switch on the 521 control panel must be jack-plugged.

Cards containing the factors in the calculation are placed in the 521 hopper face down, 12 edge leading. The cards are normally fed continuously at a speed of 100 cards a minute, the calculation for each card being performed from the time that the trailing edge of the card clears the first reading station until about the time when its leading edge reaches the punching station.

There are three types of non-accumulating[1] storage units into which factors can be entered on the read cycle from cards or from the emitter:

1. Factor Storage Units

Six Factor Storage units of eight positions each are standard, and up to three more groups of two units each may be added as optional features. Up to six Factor Storage units can, as an optional feature, be split so that each can hold two factors, one of three and one of five positions. Each unit has only one Read In hub, but the Read Out hubs are divided so that the factors can be read out separately. The sign of the five-digit factor, held in the five low-order positions, governs the sign of the storage unit. The three-digit factor, held in the three high-order positions, has no sign, and is always treated by the machine as positive. Both factors can be read out simultaneously if required.

In order to read in a factor from a card, the First Reading brushes are connected to the Factor Storage Entry hubs, and the Factor Storage Read In hub is impulsed, normally with an X impulse (read from the card) or a Card Cycles impulse. Reading in fresh information to a Factor Storage unit clears the information previously stored in it. For this reason a 12 impulse is not normally used to read in a storage unit, since the unit will be cleared before the end of the previous calculation.

ENTRY OF STERLING AMOUNTS TO FACTOR STORAGE UNITS. The first six Factor Storage units can receive sterling amounts: the low-order hub registers the X punch in a sterling field as 10d. and the 12 punch as 11d., provided that the Sterling hubs on the 604 panel are jack-plugged. Shillings are wired to positions 2 and 3 and pounds to the remaining positions. A Card Cycles or X impulse is used to impulse the Read In hub of the unit concerned (the Sterling Card Cycles impulses are NOT used for this purpose). If Sterling is not jack-plugged, the X or 12 punch entered to the units hub of a Factor Storage unit will affect the sign of the unit (see Sign Control).

SELECTION OF STERLING AMOUNTS TO FACTOR STORAGE UNITS. Sterling fields in a card may have to be selected, or the Factor Storage unit selected, according to an X or 12 punch in a card. When this is the case, the X or 12 control punch is used to pick up a selector at its IPU, the Factor Storage Read In hub is impulsed with a Card Cycles impulse, and the brush reading the pence column of the field (which may contain an X or 12 punch) is wired to one of the four X-R Delay In hubs. The corresponding X-R Delay Out hub is connected (via the selector) to the low-order hub of the Factor Storage unit.

2. General Storage Units

The Model 004 is equipped with eight General Storage units, four of three positions and four of five positions. Two General Storage units can be used together (see Assigning General Storage Units) to provide six- or eight-position storage units.

In order to read a factor into a General Storage unit from a card, the First Reading brushes are connected to the General Storage Entry hubs, and an X impulse (from the card), or a Card Cycles impulse is taken to the appropriate General Storage Read In hub.

3. Multiplier Quotient Unit

The MQ unit is primarily used in connection with multiplication and division during calculation time, but it can also be used for storing a factor on a read cycle. It has five entry hubs on the 521 control panel which can be connected to any Reading hubs. The MQ Read In hub on the 521 control panel is impulsed with an X (from the card) or a Card Cycles impulse.

Sign Control

The units position of the MQ unit, of a Factor Storage unit, or of a General Storage unit serves two purposes. It will register a digit 0–9, and if

[1] Care should be taken when entering information from card columns which have more than one punch in them—see Sign Control.

it also receives an X or 12 impulse when reading in, the amount is automatically registered as a negative. Each of these units also has a Sign Control Entry hub adjacent to its units hub, which accepts any digit (12–9) impulse to cause the factor entering the unit to be registered as a negative amount. When reading in a factor from a card to the MQ unit or a General Storage unit, an X punch over any column, or over the units position for reasons other than sign control, must be eliminated by a column split. Without elimination in other than the units position, an incorrect zero may be entered. More than a single digit in a column causes the sum of the digits to enter storage without a carry.

When Sterling is jack-plugged, the low-order positions of Factor Storage units 1–6 accept pence values, including 10d. and 11d. (X and 12). Since the automatic sign control is therefore inoperative, the separate Sign Control Entry hub must be wired, normally through a column split, for sign control.

Card Cycles

The Card Cycles hubs emit long continuous impulses from 11 time to just after 9 time on every card feed cycle. Card Cycles impulses are chiefly used for controlling the Read In and Read Out hubs of the storage units during card cycles.

The Sterling Card Cycles impulses are used only for reading out a pence amount for punching purposes.

Pilot Selectors

Five two-position Pilot Selectors are standard; an additional ten two-position Pilot Selectors are optional. The Pick-up hubs and the selector points are on the 521 control panel.

PICK-UP HUBS. There are three Pick-up hubs or each Pilot Selector.

(1) *XPU.* This hub accepts X or 12 impulses. The selector transfers at the beginning of the following cycle, and remains transferred until the end of that cycle.

(2) *DPU.* This hub accepts any digit impulse 12 to 9. The selector transfers at the beginning of the following cycle, and remains transferred until the end of that cycle.

(3) *IPU.* This hub accepts any impulse. The selector transfers immediately its IPU is impulsed, and remains transferred until the end of the same cycle.

THE COUPLING EXIT HUB. The Coupling Exit hub emits a short impulse when the corresponding Pilot Selector transfers after being picked up by its X or D Pick-up. The Coupling Exit is normally used to pick up Punch or Calculator Selectors.

The Coupling Exit and the IPU of a Pilot Selector are common.

Punch Selectors

Eight five-position Punch Selectors are standard; an additional four five-position Punch Selectors are optional. The Pick-up hubs and the selector points are on the 521 control panel.

A Punch Selector has only one Pick-up hub—the Immediate Pick-up hub—which accepts any impulse. A Punch Selector transfers immediately its Pick-up hub is impulsed, and stays transferred for the remainder of the cycle.

Calculator Selectors

It is not possible to transfer a selector during the course of a calculation, but a Calculator Selector can be transferred for the whole of the calculation period. The program can therefore be modified for particular cards by selecting Program Exits and Step Suppression impulses. A Calculator Selector's points are on the 604 panel, and its Pick-up hub is on the 521 panel.

Eight five-position Calculator Selectors are standard, and each has one Pick-up hub. The Pick-up hub accepts any digit impulse 12 to 9 during a card cycle in order to transfer the Calculator Selector for the whole of the following calculation period.

Calculator Selector Split

The Calculator Selector Split is an optional device which enables any Calculator Selector to be split, each five-position selector being divided into a two-position selector and a three-position selector. Corresponding additional Pick-up hubs are provided on the 521 control panel.

Negative Balance Selectors

One two-position Negative Balance Selector is standard; three additional two-position Negative Balance Selectors are optional. A Negative Balance Selector is transferred for the duration of the following card cycle according to a result obtained during calculation; its Pick-up hub is on the 604 panel and its selector points are on the 521 control panel. It also has a Coupling Exit on the 521 control panel which emits a continuous impulse for the whole of the time that the selector is transferred. The Coupling Exit is used to control Pilot Selectors or Punch Selectors' See also Part 2, Balance Test for Selector Pick-up Hubs.

Digit Selectors

Two Digit Selectors are standard on the 521; two more may be fitted if there is no Half-Time Emitter, one more if there is a Half-Time Emitter. Besides their normal use, they can be converted into Digit Emitters by connecting the Digit Impulse hubs to the Common hubs of the Digit Selectors.

Half-Time Emitter

This device is optional. It is similar to a Digit Emitter except that the hubs emit impulses half a point after the number indicated. For example, the 12 hub emits an impulse between 12 and X time, and the 0 hub emits an impulse between 0 and 1 time.

A Half-Time Emitter hub is normally connected to the Pick-up hub of a Punch Selector or the IPU of a Pilot Selector to transfer the selector during the course of a card cycle.

Column Splits

Twelve Column Splits are standard on the 521' and up to ten additional Column Splits can be installed. A Column Split is a selector which is automatically transferred for 12 and X time every cycle. It is used for filtering control punches placed over data fields.

Part 2 : Calculation

During calculation a Factor Storage unit can only read out the factor it contains and cannot read in, but a General Storage unit can read in as well as read out factors. The Exits and Entries of all storage units, the MQ unit and the Counter are connected together internally by an eight-position channel. This means that only one factor may be transferred on any one program step.

During calculation the Read Out hub of a unit is impulsed in order to release the number contained in the unit into the channel. The number can then enter other General Storage units (but not a Factor Storage unit), the Counter, or the MQ unit, provided the Read In hub of the receiving unit is impulsed. For a detailed explanation of the operation of the eight-position channel, see the 604/001 manual of operation.

The Counter accumulates positive and negative numbers, receives products resulting from multiplications, and must contain the dividend prior to a division step. The MQ unit develops the quotient on a division step and must contain the multiplier prior to a multiplication step.

As a result of design considerations the Counter operates in complement form. Thus, when a positive number is added into the Counter, the number is automatically converted to complement form. As a result, if the number is simultaneously entered into another unit it will be retained in complement form in that unit. If, on the other hand, the number is subtracted into the Counter, it will enter the storage unit in true form.

Shift Unit

The Counter has 13 positions. A number is normally read into the Counter so that its units digit is entered into position 1 of the Counter, but, if required, a number can be entered higher up the Counter. For example, if the Read Units Into 3 hub is impulsed on a read in step, the number is shifted two positions to the left in the Counter so that the units digit occupies position 3. A Read Units Into instruction can be given when transferring numbers from a storage unit or the emitter to another storage unit or the MQ unit.

A number can also be shifted when the Counter is read out and the number contained in it is accepted by a storage unit. When reading out of the Counter, however, the shift is in the opposite direction to that when reading in. For example, if a thirteen-digit number is read into an eight-position General Storage unit and the Read Units Out of 6 hub is impulsed simultaneously, the last five digits of the number are dropped. The number which was in position 6 of the Counter is stored in the units position of the storage unit. This procedure is chiefly used for dropping unwanted decimal parts of numbers.

The Read Units Into and Read Units Out of hubs are the same, the direction of shift being governed by whether a factor is read from storage (Read Units Into) or from the Counter (Read Units Out of). The maximum shift in either direction is five positions.

Assigning General Storage Units

Some of the General Storage units can be *assigned* so that the units position, instead of being connected to position 1 of the channel, reads into or receives from either position 4 or position 6 of the channel. In this way two three-position General Storage units can be used together to hold a six-digit number, or a three- and a five-position unit can be used together to hold an eight-digit number. If, for example, G 1 is assigned to channels 8 to 6, and G 1 and G 2 are read out simultaneously, the number in G 1 and G 2 would enter the first eight positions of the Counter. Similarly, when reading out of the Counter and reading into G 1 and G 2, the eight-digit number is stored in G 1 and G 2. The Read In or Read Out hubs of both the units must be impulsed on the same program step. When a storage unit is assigned, its Sign Control hub is inactive.

The General Storage units are assigned by connecting the Assignment hub (6.4, 8.6) of the General Storage unit to the hub above it.

G 1 can be assigned to channels 6 to 4 or 8 to 6.
G 3 can be assigned to channels 8 to 6.
G 5 can be assigned to channels 6 to 4 or 8 to 6.
G 7 can be assigned to channels 8 to 6.

Should the assignment of a General Storage unit be dependent on particular cards, the Control hubs on the 604 panel must be used to assign the storage unit instead of the ones normally used. The Control hubs are connected via a Calculator Selector to the General Storage Assignment hub.

Program Unit

PROGRAM EXITS. The Model 004 is equipped with 70 sets of three Program Exits. As soon as the 9 edge of a card has passed First Reading, calculation time commences and the first set of Program Exits emit, to be followed in turn by each of the remaining 69 sets of Program Exits. The impulses emitted from the hubs making up one set of Exits are used to control functions on that step of the program. For example, if on a program step,

(1) the G 1 Read Out hub,
(2) the Counter Control Plus hub,
and (3) the Read Units Into 3 hub

are impulsed, the number stored in G 1 is added into the Counter with its units digit in position 3 of the Counter.

Program Exit impulses should not be split-wired to more than one control hub except when:

(1) a Sterling Factor Storage unit is used decimally and one Program Exit is connected to both Read Out hubs;
or (2) two General Storage units are used in conjunction by assigning one of them, and one Program Exit is connected to their Read In or Read Out hubs.[2]

[2] When the Read In or Read Out hubs have been split-wired on the 604 panel, it is not possible to read in or read out the two General Storage units separately on the 521 panel.

PROGRAM EXIT EXPANSION. The number of Program Exits can be increased by means of the optional Program Exit Expansion unit. This unit consists of fifteen sets of three hubs. When a Program Exit is wired to the Entry hub, the two Exit hubs emit Program Exit impulses. In this way, the Program Exits available on a particular step can be increased.

PROGRAM END. The Program End hubs must be impulsed at the end of the program to prevent indefinite repetition of the last program loop (steps 49 to 70). Impulsing Program End causes the program unit to stop operating at the end of the loop on which it is impulsed (i.e., step 24, 48, or 70). If the impulse to Program End is selected, the subsequent steps in the same program loop must be suppressed. Program End must not be impulsed on the same step as:

(1) Multiplication
(2) Division
(3) Zero Check
(4) Counter Reset
(5) CON (Sterling Conversion)

PROGRAM REPEAT. Program Repeat is an optional device. If the Program Repeat hubs on the 604 control panel are impulsed with a Program Exit, and any subsequent step on which Program End is impulsed is suppressed, then, on completion of step 70, the program will be repeated from the beginning until Program End is allowed to become effective.

Calculation Time

If the maximum speed of processing is to be attained, the calculation for each card should be complete by the time the card is positioned for punching. This means that pence values should be stored ready for punching within 145 electronic cycles, and that the whole calculation should be completed within 230 electronic cycles.

The duration of a program depends on the number of electronic cycles taken by the calculation, and this number is not directly proportional to number of steps. A program with many steps might take fewer electronic cycles than a program with less steps, and therefore be shorter in duration. For information on the way in which the number of electronic cycles in a program is calculated, see the 604/001 manual.

If the calculation is not complete by the time the card is positioned for punching, one of two things can happen, according to the way in which the control panels have been wired.

(1) UNFINISHED PROGRAM. An incompletely calculated card is not punched. The Unfinished Program hubs on the 521 control panel emit an X impulse on the following card cycle if the calculation has not been completed by that time. The X impulse is wired either to a Stop hub to stop the machine, or to an Offset hub in order to offset the card for which the calculation was incomplete. If the Stop hub is impulsed the Unfinished Program error light comes on (see also Part 3). If the incompletely calculated cards are few, they can be offset in the stacker and recalculated by feeding them again and depressing the Start and Stop buttons alternately. This procedure provides a longer calculation period. If, however, the unpunched cards are numerous Delay Calculate can be used.

(2) DELAY CALCULATE. The Delay Calculate[3] hubs on the 521 control panel receive any impulse on a card cycle (an X from a card, for example, or a Card Cycles impulse) to delay card feeding if the program which follows exceeds 145 electronic cycles. If the program does not take 145 electronic cycles, no delay occurs; but if it exceeds 145 electronic cycles the card is arrested and the program proceeds until completion, when card feeding resumes and punching takes place. An unnecessary delay will result if Delay Calculate is wired and the calculation takes more than 145 but less than 230 electronic cycles. These delays should be avoided by wiring Delay Calculate only after careful consideration. The impulse to Delay Calculate may be selected.

Modifying Programs

Programs can be modified for different cards by picking up a Calculator Selector (see Part 1). A Calculator Selector cannot transfer or revert to normal during the course of a program, however, and consequently it cannot affect a program as a result of conditions which arise during the program. Should the program need to be modified as it progresses, certain program steps must be suppressed. A program step still takes one electronic cycle when suppressed, but none of the functions wired on that step takes place.

PROGRAM SUPPRESS HUBS. There are 70 Program Suppress hubs on the 604 panel, one hub corresponding to each set of Program Exits. They are impulsed from suppression hubs, of which there are three types:

(1) Suppress Without Balance Test hubs. These hubs emit on all program steps and are connected to the Program Suppress hubs via a Calculator Selector.

(2) Suppress on Plus Balance hubs and Suppress on Minus Balance hubs. These hubs emit impulses which are used for step suppression but, as their names imply, they depend on the result of a test which is made to detect the sign of the balance in the Counter. The sign of the balance in the Counter is tested by impulsing the Balance Test for Step Suppression hubs with a Program Exit; at the end of the step, the balance in the Counter is tested, and on the following cycle either the Suppress on Plus Balance or the Suppress on Minus Balance hubs commence emitting, depending on the sign of the balance detected. A Balance Test must not be performed on a multiplication or division step, or on a step on which the CON (Sterling Conversion) hub is impulsed, but it can be performed on any other step. If a plus balance is detected in the Counter, the Suppress on Plus Balance hubs emit on the step following that on which the balance was tested, and continue to emit on every step until the step following the one on which the balance in the Counter is again tested. If the balance again proves to be

[3] During program advance operations, idle cycling in the 521 may sometimes occur if the wire to Delay Calculate is not removed.

positive the Suppress on Plus Balance hubs emit as before, the sequence being unbroken. If the second balance test discovers a minus balance in the Counter, the Suppress on Minus Balance hubs start emitting instead of the Suppress on Plus Balance hubs on the cycle following the test. It follows that once a balance test has been made during a program, thereafter either the Suppress on Plus Balance hubs *or* the Suppress on Minus Balance hubs emit on all remaining steps, depending on the sign of the balance in the Counter when last tested.

(3) Group Suppress Hubs. There are four[4] sets of Group Suppress hubs. Each set has a Pick-up hub, a Drop-out hub and an Exit hub. When the Pick-up hub of a set is impulsed with a Program Exit, the Exit hub emits on all succeeding steps until the program step following the one on which the Drop-out hub is impulsed from a Program Exit.

Balance Test for Selector Pick-up Hubs

As already described in Part 1, Negative Balance Selectors on the 521 control panel are controlled from their Pick-up hubs on the 604 panel. A Negative Balance Selector transfers for the card cycle following the program on which the Balance Test for Selector Pick-up hub is impulsed from a Program Exit, if the balance in the Counter at the end of that program step is negative.

The Balance Test for Selector Pick-up hubs must not be impulsed on a multiplication or a division step or when CON (Sterling Conversion) is impulsed.

Multiplication

If a storage unit is read out and the Multiply Plus hub on the 604 panel is impulsed on a program step, the Counter develops the product of the number read out from storage and the number already contained in the MQ unit. The product is added to the number previously contained in the counter. If the Multiply Minus hub is impulsed, the product is subtracted from the number already in the Counter. For further information, see the 604/001 manual.

Division

If a storage unit is read out and the Divide hub is impulsed on a program step, the number in the Counter is divided by the number read out from storage, and the quotient appears in the MQ unit. Any remainder resulting from the division is left in the Counter at the end of the step.[5] The MQ unit is automatically reset at the beginning of the division step. Should the quotient exceed five digits, the division step will be cancelled and zero will be left in the MQ unit. For further information, see the 604/001 manual.

Half-Adjust

If the Half-Adjust hub on the 604 control panel is impulsed from a Program Exit, a 5 will automatically be added into or subtracted from the units position of the Counter on that step, depending on the sign of the number already in the Counter. If required, the 5 can be shifted when reading in.

Emitter

The 604 is equipped with nine Emitter hubs to enable a digit to be emitted into a General Storage unit, the MQ unit or the Counter. The hub of the digit required to be emitted is impulsed from a Program Exit and the digit is emitted to the units position of the channel on that step. Read In shift can be employed if required. Only one digit may be emitted on any one program step, unless the optional tens and—on non-sterling machines—hundreds and thousands emitters are installed. Emitted digits can be used as the divisor on a division step or as the multiplicand on a multiplication step, but no shift instruction can be given on such a step.

Zero Check

If the Zero Check hub (see the section on checking results) on the 604 panel is impulsed from a Program Exit, the 604 tests whether the number in the Counter is zero. If the number is not zero, the Zero Check hubs on the 521 panel emit at X time on the following card cycle. The X impulse is normally used to stop the machine, offset the card, or prevent punching (see Part 3). The Read Units Into hubs can be impulsed on the same step, so that only some of the high-order digits of the number in the Counter are zero checked. For example, supposing the number in the Counter had three decimal places which were not to be zero checked, the Read Units Into 4 hub would be impulsed on the same step as the Zero Check hub in order to zero check only the required numbers.

At the beginning of the step following that on which Zero Check is impulsed, the Counter is automatically reset to zero.

Zero Test

The Zero Test device is an optional feature which may be installed instead of Zero Check. The Zero Test hubs are impulsed from a Program Exit in order to distinguish a zero balance in the Counter. As a result, program steps can be suppressed by means of the Suppress on Zero or Suppress on Non-Zero hubs. The Counter is not reset, but if a shift instruction has been given in order to zero test high-order positions only, the balance will have been increased by 1 in the lowest position zero tested. An additional Counter control hub, Counter Reset,[5] is provided to reset the Counter before the following step. The Zero Check hubs on the 521 panel are replaced by Zero Test hubs which function in exactly the same way. If the Counter does not contain a zero when the Zero Test step takes place, the Zero Test hubs on the 521 panel will emit at X time on the following cycle.

[4] Only three sets of Group Suppress hubs are available on sterling machines.

[5] Although installed as part of the Zero Test device, Counter Reset may be used on a division step, when the remainder standing in the Counter at the end of the division step is lost and the Counter reset before the following program step.

Sterling

When sterling calculations are performed, the ST (Sterling) hubs on the 604 panel are jack-plugged. The entry of sterling amounts into Factor Storage has already been dealt with in Part 1. On sterling machines, the lower Read Out hubs (marked p) of Factor Storages 1 to 6 are used to read out only the position holding the pence amount, i.e., the low-order position of the Factor Storage unit.

Impulsing the Read Out p hub of a Factor Storage unit causes the pence amount to enter the first two positions of the channel. Impulsing the upper Read Out hub causes the pounds and shillings to enter the second, third and higher positions of the channel, the shillings being read out as decimals of a pound. A shift instruction can be given if required. Whenever ST is jack-plugged, it follows that the two Read Out hubs of the Sterling Factor Storage units are never impulsed on the same program step, as overlapping of the decimal pounds and the pence amounts would arise.

If the ST hubs are not jack-plugged and the first six Factor Storage units are used to store decimal numbers, both Read Out hubs of those Factor Storage units must be impulsed simultaneously to read out the whole number. For this purpose, a Program Exit can be split-wired to the two Factor Storage Read Out hubs.

CON (STERLING CONVERSION). The Sterling Conversion device automatically converts a decimal fraction of pounds in the Counter into a whole number of shillings, leaving the pence remainder, if any, as a decimal of pounds. If a Program Exit is wired to the CON hub the numbers in positions 3 and 4 of the Counter are converted into the corresponding shillings amount. The shillings amount stands in the same positions of the Counter at the end of the step (this process occupies five electronic cycles).[6] For example, supposing £11·7800 is in the Counter; at the end of the Sterling Conversion step, the 11·78 is converted to 1115, representing 11 pounds 15 shillings. The remainder, £0·03, which represents pence, will be lost unless the C.S.R. hub is connected to the Read In hub of a General Storage unit, in which case the remainder, 3, will be stored in the units position of the General Storage unit. Digits in positions other than 3 and 4 of the Counter are not affected by this operation. If, for example, the amount were £11·7814, the Counter would contain 11·1514 at the end of the conversion step.

Part 3 : Punching Results

Information resulting from calculations can be punched into cards only from General Storage units or the Counter.

The Counter and the General Storage units have control hubs (Read Out hubs for the Storage Units, and the Read Out and Read Out/Reset hubs for the Counter) and Exit hubs on the 521 panel. The control hubs must be impulsed by Card Cycles impulses in order to cause reading out for punching purposes; the Counter Exit hubs and General Storage Exit hubs are connected to the Punching hubs.

Emitting Information for Punching

A Digit Impulse hub connected to the Common of a Digit Selector will convert that Digit Selector into an emitter which can be connected to the Punching hubs.

The 0-X hubs emit 0 and X impulses on all cycles. They are used, via a Column Split, when punching zeros in order to enlarge a field, or when punching an X for card identification purposes.

Selecting Information for Punching

Selection of fields in the card and selection of the storage exit from which punching is to take place is usually dependent either on the type of card to be punched or on a particular kind of result obtained during calculation. If it is dependent on the card, Punch Selectors are coupled to a Pilot Selector whose XPU or DPU is impulsed from First Reading. If it is dependent on a result obtained during calculation, Punch Selectors are coupled to a Negative Balance Selector. (See Part 1 for further information on Selectors.)

Prevention of Punching

Certain cards, such as lead cards and master cards, may not need to be punched. Such cards can be distinguished from normal cards by an X or a digit punch. The distinguishing punch is wired from First Reading to the Punch Suppress hubs, which accept any impulse to suppress all punching on the following cycle.

An Immediate Punch Suppress unit can also be fitted, if required. The I.P.S. hubs receive any type of impulse to suppress punching on the same cycle. If punching has already commenced when the I.P.S. hubs are impulsed, punching is prevented for the remainder of the cycle.

Stop and Offset Hubs

Errors may be detected, or conditions may arise on the calculation of some cards, which necessitate stopping the machine or distinguishing the card which has caused the unusual or error

[6] On Program Test, a Conversion step requires five depressions of the Program Advance key.

condition. If the machine is not stopped, the card which needs to be distinguished can be offset. On removal from the stacker, the offset cards are easily recognised.

Since an error in a card or an error arising from information punched in a card can be detected at three different stages in the card's passage through the 521, there are three sets of Stop and Offset hubs, which are impulsed with an X.

The First Reading Stop and Offset hubs are used when an error is detected at First Reading or during programming between First Reading and Punching. The machine then stops (or operates the offset device) when the card causing the error condition is the top card in the stacker. These hubs are usually wired from Unfinished Program, Zero Check (performed on a second run) or DPBC (detected at First Reading).

The Punch Stop and Punch Offset hubs are used when an error condition arises during punching; like the First Reading Stop and Offset hubs, they accept impulses either to stop the machine or to offset the card when the card causing the condition reaches the stacker. They are normally wired from the Product Overflow Out hubs (see Product Overflow In-Out).

The Second Reading Stop and Offset hubs are used for the same purposes as the other Stop and Offset hubs. They are normally wired from the Double Punch and Blank Column hubs (see Part 4).

For a diagrammatic summary of the uses of the Stop and Offset hubs, see the 604/001 manual. Note that the offset device is an optional feature.

Product Overflow

The Product Overflow In hubs are connected to Counter Exits or General Storage Exits which are not wired to punch but which in exceptional circumstances might emit a digit other than 0 (e.g., when an answer is developed which is too large for the allotted field in the card). The Product Overflow In hubs receive a digit (1–9) and cause an X to be emitted on the following cycle from the Out hubs. The Product Overflow Out hubs are normally connected to the Punch Stop hubs in order to stop the machine when the error card reaches the stacker.

Sterling

The punching of a pence amount means that a value held in two storage positions must be converted, for punching in a single card column.

The 521 is equipped with eight General Storage Pence Exits, one for each General Storage unit, which are operative when the corresponding Pence Test hubs on the 604 panel are jack-plugged. The pence amount is stored in the two low-order positions of a General Storage unit, but instead of wiring these General Storage Exits to Punching hubs, the single Pence Exit hub for that General Storage unit is used.

When reading out storage units from which pence amounts are punched, a Sterling Card Cycles impulse must be used.

Sign Control

If a negative quantity is read out from the Counter or a General Storage unit to punch, the units column is automatically overpunched with an X. If the X is not required in the units column, the units exit position must be taken through a Column Split. The sign hub has to be used for indication of a negative sterling amount, however, as a General Storage Pence Exit does not emit a sign impulse.

The sign hub emits all the impulses X to 9 when the unit read out contains a negative quantity. If the X over-punch from the units hubs is not used, the sign hub is connected to the common of a Column Split or Digit Selector in order to select the X (or digit) which is used to denote the negative number.

Part 4 : Checking Results

The 604/001 manual gives examples of the checking of multiplication, division and simultaneous multiplication and checking. Only brief reference will therefore be made to the methods of checking and to the functions of the hubs provided for this purpose.

Calculations can be of such a nature that cards can be proved in groups, but if this is not possible every card must be checked. There are two main ways of checking each card:

(1) To pass the cards through the machine twice, using a modified program on the second run which uses different storage units and reverses the order of calculation; e.g., in the simple case of $A \times B = C$, the checking run would calculate A by dividing C by B. The calculated A can be subtracted from factor A and the result zero checked. Alternatively, C is recalculated and punched in the same field as it was originally punched, the card columns being tested for double punching at Second Reading.

(2) To perform the calculations twice on the same run. This is done by performing the calculation a second time when the card passes Second Reading. The factors, and the answer which has been punched as a result of reading the factors at First Reading, are read again at Second Reading. The factors are recalculated, using the reversal procedure of method 1, and the

answer is subtracted from the original factor. The result of the subtraction is zero checked and the Zero Check hubs on the 521 panel are connected to Second Reading Offset or Stop. The Program Exits must be wired so that the 604 performs calculations on two cards during the same program. It will perform the original calculations for the card passing First Reading and the check calculation for the card passing Second Reading on every program. The check calculation is usually performed at the beginning of the program in order to leave storage units clear for the second part of the program.

Double Punch and Blank Column Entry

There are 10 standard (40 maximum) Double Punch and Blank Column Entry hubs which can be connected to the First or Second Reading brushes in order to detect double punches or blank columns. Each Double Punch and Blank Column Entry hub has a corresponding Blank Column switch. If the Blank Column switch is not wired, the Double Punch and Blank Column Entry hub checks only for double punching; if the Blank Column switch is wired, the Double Punch and Blank Column Entry hub checks for blank columns as well as for double punched columns.

Double Punch and Blank Column Exit

These hubs are normally used as exits from the Double Punch and Blank Column Entry hubs and are connected to Punching hubs for gang punching operations. They can also be used as entries in order to check for blank columns only, with the Blank Column switch jack-plugged.

DPBC

When a double punched or blank column is detected the four common DPBC hubs emit an X impulse on the following cycle. The DPBC hubs are normally connected to the Second Reading Stop or Offset hubs.

Part 5 : Gang Punching

This is dealt with fully in the 604/001 manual. Briefly, the 521 can be used, by wiring the calculate switch off, for gang punching information into cards, either from master cards (which can be interspersed) or from an emitter source. The 521 can also be used to gang punch information into cards during a calculating operation.

The normal wiring for a gang punching operation is from Second Reading to the Punching hubs. If it is also necessary to check for double punching and blank columns, the Second Reading brushes are connected to the Double Punch and Blank Column Entry hubs and the Double Punch and Blank Column Exits are connected to the Punching hubs.

If it is required to check numerical fields for blank columns only, the wiring is reversed: the Second Reading hub is connected to the Double Punch and Blank Column Exit, and the Double Punch and Blank Column Entry is taken on to the Punching hub.

In both cases, if a column contains more than one punch, only the first is transmitted for punching.

Part 6 : Lights, Switches and Control Buttons

521

Main Line Switch

When the Main Line switch on the punch is turned on and the Power On key on the calculating unit is depressed, power is supplied to both units. Operation may be started about three minutes later, during which time the electronic tubes warm up. The red unlabelled light on the punch comes on when this switch is turned on, and the machine is then ready for operation.

Start Key

The Start key is depressed to feed the cards and to start calculation. This key is effective only when the unlabelled lights on the 521 and the 604 are on, unless the punch unit is used independently, when the Start key may be depressed as soon as the Main Line switch is turned on.

Stop Key

The Stop key stops both the punch and calculating units when depressed.

Reset Key

When an error is signalled by one of the four lights on the punch, the machine may be restarted only after the Reset key is depressed.

Light (Unlabelled)

The red light comes on as soon as the machine is ready to operate. It goes off when cards pass through the machine. It also goes off if a control panel in either machine is removed.

Unfinished Program Light

The red Unfinished Program light comes on when the machine stops as a result of the Unfinished Program hub being connected to one of the Stop hubs.

Double Punch and Blank Column Light

The red Double Punch and Blank Column light comes on when the machine stops as a result of the detection of a Double Punch or Blank Column error.

Zero Check Light

The red Zero Check light comes on when the machine stops as a result of the detection of a non-zero balance.

Product Overflow Light

The red Product Overflow light comes on when the machine stops as a result of the detection of a Product Overflow condition.

604

Power On Key, Power Off Key

The Power On and Off keys operate as a main line switch for the calculating unit, provided the Main Line switch on the punch unit is on. When the Power On key is depressed, power is supplied to the electronic tubes, the Start light comes on immediately, and the green unlabelled light comes on after about three minutes. When the Power Off key is depressed, power to the calculating unit is turned off.

Start Light

This red light comes on when the Power On key is depressed.

Light (Unlabelled)

This green light comes on about three minutes after the Main Line switch on the 521 and the Power On key on the 604 have been turned on. It indicates that the machine is ready to operate. The light goes off as cards pass through the punch unit and comes on again when feeding stops. It also goes off when the control panel in the calculating unit is removed.

Program Test Key, Program Test Light

The Program Test key is depressed in order to operate the 604 one step at a time and check programs. The Program Test light is on when program testing. The 604 is returned to normal operation by depressing the Program Test key once more.

Control Panel Light

This red light comes on when the control panel is removed from the 604.

Program Advance Key

When program testing, program steps are taken one at a time by depressing the Program Advance key.

Neon Panels

The 604 model 004 is equipped with two neon panels. One is designed to show which program step has just taken place and all the functions wired to take place on that step, and also to reveal the numbers contained in the General Storage units, the MQ unit and the Counter at the end of the step. Counter Reset, however, takes effect at the beginning of the following step.

The other neon panel shows the Read Out controls of all the Factor Storage units and the contents of any one Factor Storage unit. The Factor Storage unit whose contents are to be displayed is selected by a manual rotary switch. There are two control buttons on a sterling machine, the Pence Control and the Factor Storage Control. When the rotary switch has been set to a unit numbered from 1 to 6, depression of the Pence Control button reveals on the display panel what is in the low-order position of the storage unit, the pence amount being shown in positions 1 and 2 on the display panel. Depression of the Factor Storage Control button reveals what is contained in the remainder of the storage unit. Shillings in a sterling amount are shown as decimals of a pound in positions 2 and 3 on the display panel. In order to display decimal numbers held in these Factor Storage units, both buttons are depressed simultaneously. When displaying the contents of Factor Storage units 7 to 12, only the Factor Storage Control button is depressed.

The Factor Storage display rotary switch and control buttons may only be used during program testing or when both machines are idling. They should not be used during normal running.

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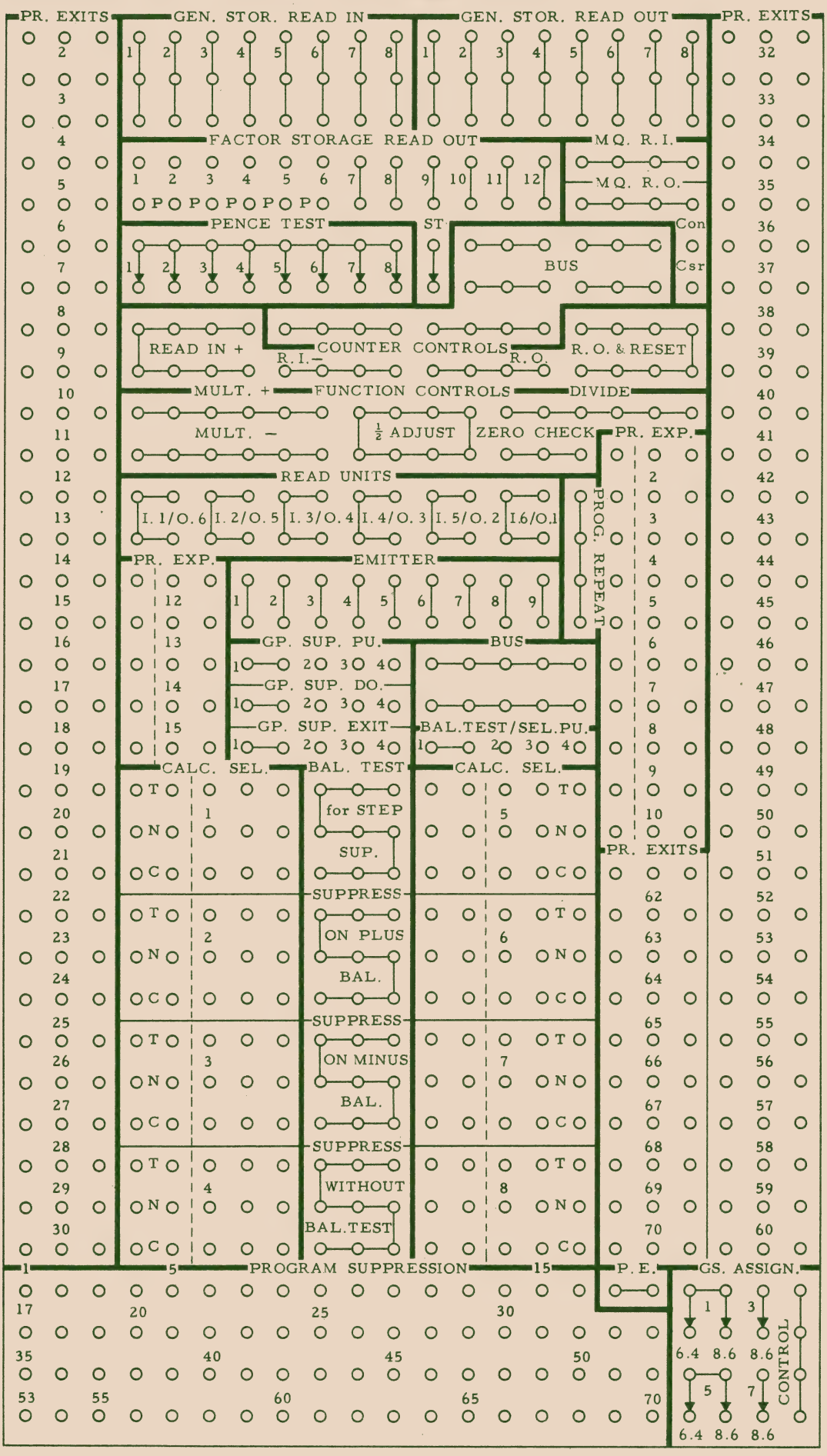
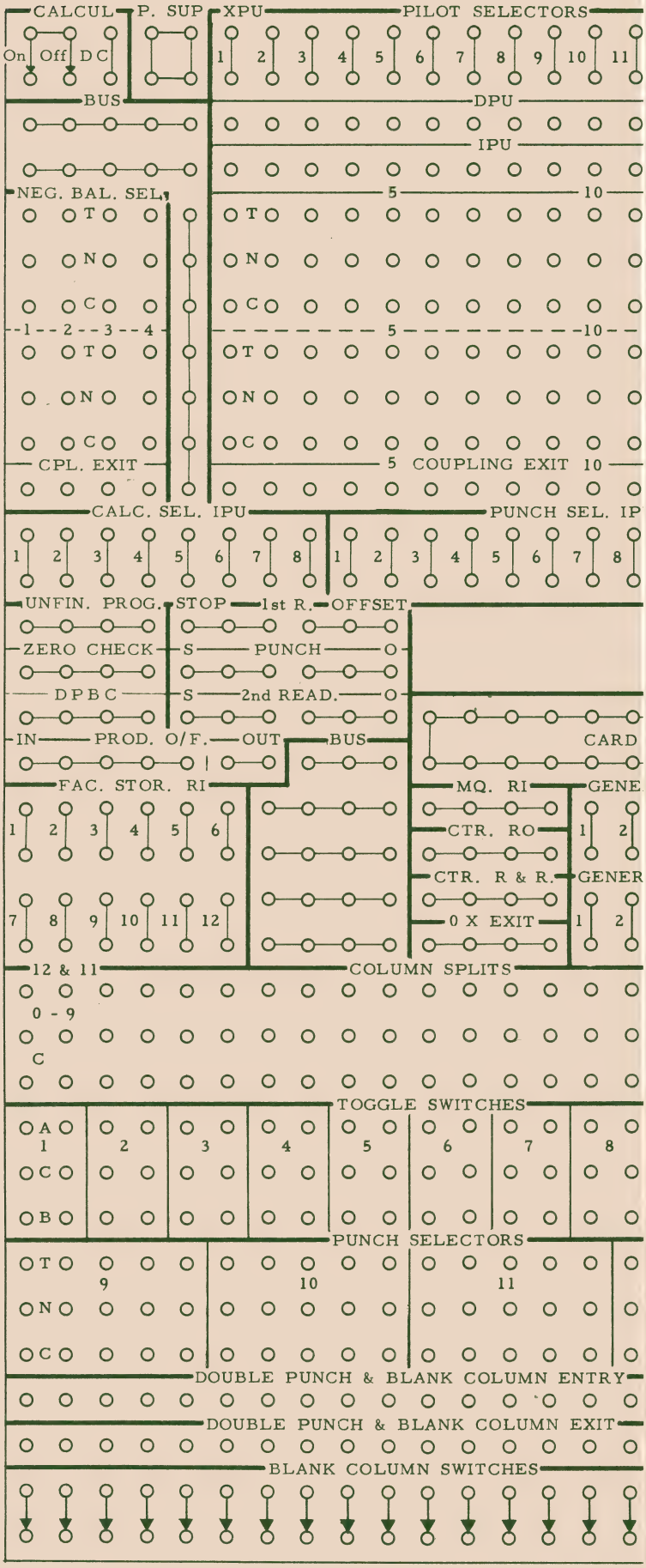
IBM 604 Electronic Calculator Control Panel Diagram



IBM 521 Read Punch Unit

(for use with IBM 604 Electronic Calculat

Control Panel Diagram



UK Form 25-5911

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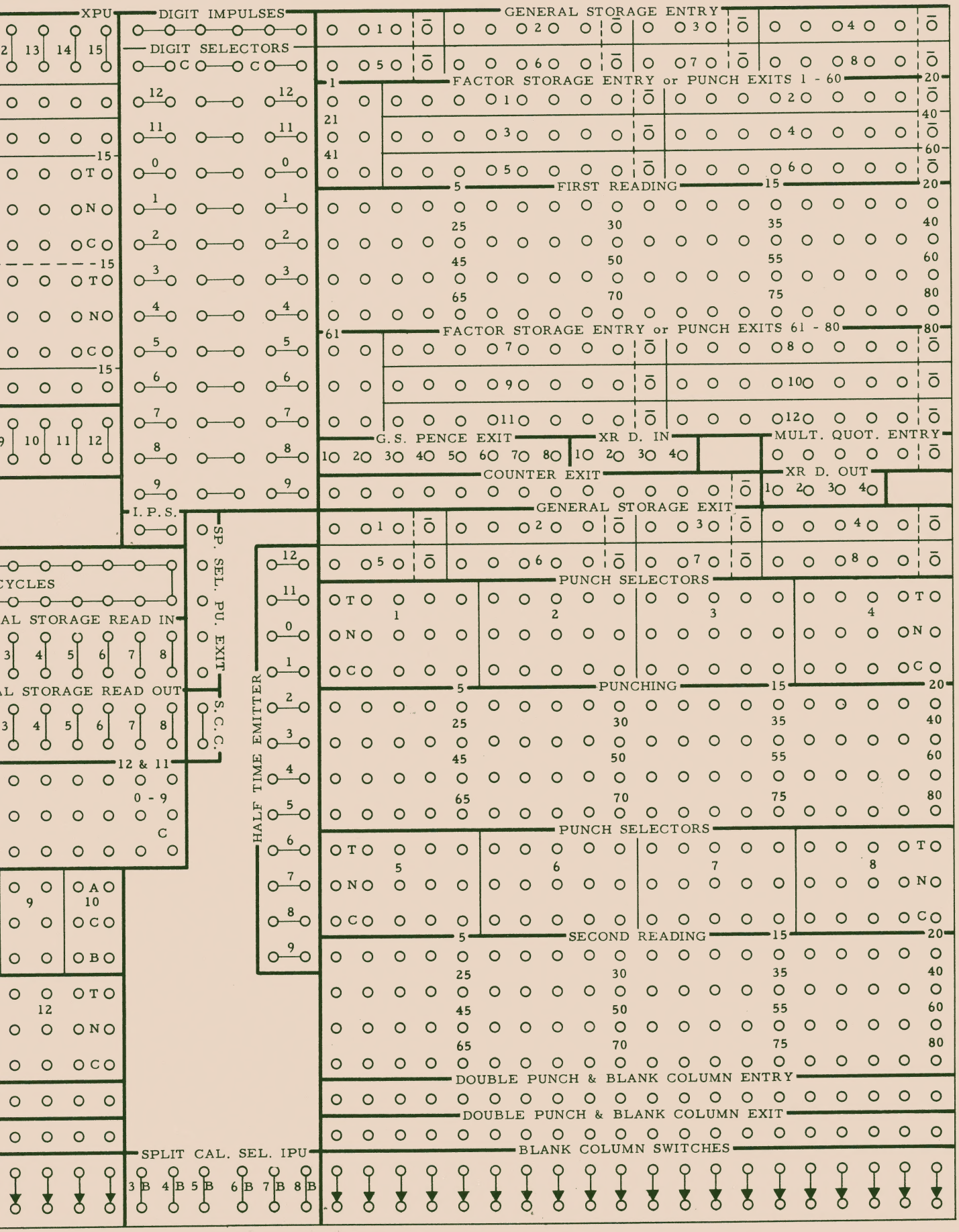
XPU
DIGIT IMPULSES
DIGIT SELECTORS
GENERAL STORAGE ENTRY
FACTOR STORAGE ENTRY or PUNCH EXITS 1 - 60
FIRST READING
FACTOR STORAGE ENTRY or PUNCH EXITS 61 - 80
G.S. PENCE EXIT
XR D. IN
MULT. QUOT. ENTRY
COUNTER EXIT
XR D. OUT
GENERAL STORAGE EXIT
I. P. S.
SP. SEL. PU. EXIT
S. C. C.
CYCLES
AL STORAGE READ IN
AL STORAGE READ OUT
12 & 11
0 - 9
C
HALF TIME EMITTER
PUNCH SELECTORS
PUNCHING
PUNCH SELECTORS
SECOND READING
DOUBLE PUNCH & BLANK COLUMN ENTRY
DOUBLE PUNCH & BLANK COLUMN EXIT
SPLIT CAL. SEL. IPU
BLANK COLUMN SWITCHES

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